ABSTRACT

THESIS: Synthesis and Photocatalytic Activity of the MoS_2 and WS_2 Nanoparticles in Degradation of Organic Compounds

STUDENT: Derak James

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Nanoparticles of MoS_2 and WS_2 were synthesized by decomposing the appropriate metal hexacarbonyl in the presence of sulfur dissolved in decalin at 140°C. A significant fraction of the nanoparticles was ≤ 15 nm in diameter as verified by Transmission Electron Microscopy. The process was repeated in the presence of silica and then titania to produce supported metal sulfides. The unsupported nanoparticles were found to exhibit a size-dependent shift in their threshold UV-visible absorption due to quantum confinement. Photocatalytic properties of each sulfide from synthesis in decalin were explored by using each as a catalyst in the photodegradation of methylene blue by visible light. These sulfides were also used to catalyze the photodegradation of acetone.

Unsupported MoS_2 and WS_2 nanoparticles catalyzed the photodegradation of acetone under visible light of ≥ 400 nm wavelength. This is the first study reporting the photocatalytic properties of the unsupported WS_2 nanoparticles. Photodegradation of methylene blue under ≥ 435 nm irradiation was detected using unsupported WS_2 but not unsupported MoS_2, likely because activity was masked by the likely photobleaching of the dye. When deposited on silica or titania, the nanosized MoS_2 and WS_2 could be

uniformly distributed in aqueous solutions to maximize the photocatalytic efficiency. Correcting the absorbance measurements for light scattering by solids proved to be beneficial for extracting kinetic information. Both silica deposited sulfides were found to significantly increase the rate of methylene blue photodegradation, and deposited WS_2 increased this rate significantly more than deposited MoS_2. Similarly, both titania deposited sulfides significantly increased the rate of methylene blue photodegradation, and the deposited WS_2 increased this rate significantly more than the deposited MoS_2.